



## UNIVERSITY OF CALGARY

### SCHOOL OF ARCHITECTURE, PLANNING AND LANDSCAPE

## Winter 2024

Course Number	ARCH 680.19 L08	Classroom	PF 2140
Course Name	Machinic Agencies		
Pre/Co-Requisites			
Instructor	Dr Alicia Nahmad Vazquez	Office Hours/Location	By appointment
	Email:	Phone:	
Class Dates	Mandatory in-person classes: Tuesdays, January 9 – April 9, 09:00am to 11:50am		
Instructor Email Policy	Please note that all course communications must occur through your @ucalgary email, and I will respond to emails sent via student's @ucalgary emails within 48 hours. Daily communications will occur through interactive communication channels as discussed with the instructor.		
Name and Email of Teaching Assistant(s)	Arman Khalilbeigi Khameneh <arman.khalilbeigikha@ucalgary.ca>		

### Course Description:

“... the machine is a marvellous simplifier; the emancipator of the creative mind, and in time the regenerator of the creative conscience”

Frank Lloyd Wright

The Machinic Agencies elective is organized thematically under three main research topics (materials, machines and design). The elective will focus on developing critical design thinking towards the processes and meanings of design and making through a hands-on approach in which the emphasis is placed on all aspects of the relationship between virtual and physical data. The course will explore robotic fabrication-aware design methods through design techniques, robotic understanding, and material possibilites.

The current era of architectural design has been characterized by the proliferation of digital design tools and machines. While they cannot be the main drivers of the architectural project, they represent a new approach to design thinking and making. Through seminar presentations, design methods and actively testing these novel modes of design generation and physical production through focused acts of doing, the machinic agencies elective present students with

a range of opportunities to develop individual methods of practice and to hone their use of digital tools for design enquiry.

The machinic agencies elective does not pretend to be a technical instruction manual to design and fabricate with robots but a course that looks beyond digital design and fabrication tools as simple automation and embraces them as tools that enable architectural creativity as a manner of design thinking whilst still responding to complex spatial and material constraints.

The outcomes of the machinic agencies course can be broadly described as practical skills relating to design thinking in relation to tools, materials and systems. Students will acquire knowledge on how robots work, how to problem solve, plan, set them up, design their end effectors and run them with a focus on how can this knowledge be applied to inform design processes.

## **Course Hours:**

The machinic agencies elective will be delivered in 3 hours sessions one time a week during 11 weeks. The class is structured to allow for short project introductions and lectures, software demonstrations, technical tutorials supplemented by seminars, and in-depth hands-on physical and digital prototyping sessions.

The course will consist of 3 main modules. Each module will end with a submission to allow moving into exploring different digital and robotic fabrication territories and continuing the research project. The course will be structured as a collaborative team-based experiment, and each block will consist of digital and physical explorations.

The first three-class module, “**Designing for Digital Fabrication**” will introduce students to robotics, parametric design and constraints and affordances that robots enable. Students will learn modelling techniques that consider material and machine behaviour and will ask them to reflect the relationship of the parts to the whole within a digital and a physical model. During this module, students will learn the fundamentals of how robots operate, the geometric constraints and operations that are used to define their motion, and how to use them for better design. Students will learn different ways to create robot paths in 2D to create a pattern that requires from multiple colours and robot operations. Students will be using the robots for 2D multi-coloured drawing or stitching.

The second three-class module, “**Machinic agencies**” will move the learnings from the previous module into 3D space. During this module, students will explore design, machine and material constraints and learn how to calibrate and control them. The second block will seek to understand the impact of material constraints and machinic simulations in design and how to incorporate machinic constraints from early stages of the design. Students will understand the ‘line’ as the creative principle of hot-wire cutting operations and will use lines to produce

designs for robotic hot-wire cutting (RHW). The implications of the tool to the design and fabrication process from the early stages will be discussed.

The final three-class intensive block of teaching, “**Data Collection**”, will introduce students to data collection and point cloud manipulation techniques. During these three classes, explorations will be focused on exploring scanning as means to retrieve architectural data, cleaning it to extract main features, analysis and validation as new input for secondary machinic processes. Students will scan the prototype from module 2 and develop a new set of robotic coordinates and paths to perform operations upon those surfaces (3dprinting or drawing). The potential of robots to retrieve and work with information from the environment will be discussed, specifically within the context of a built environment that requires customized solutions for retrofitting or repurposing existing stock.

Finally, students are expected to **document and catalogue their 2D prototypes, 3D RHW and final data collection exercise for discussion and presentation.**

## **Course Learning Outcomes:**

Upon completion of this course, students will know and be able to:

1. Use of advanced 3D modelling tools: to explore design options in a controlled way and the material and machine parameters that influence their formation. These tools will be used as creative responses to design problems and simulate the material and machine performance.
2. Use of industrial robotic manipulators: to investigate creative responses to design problems and explore their versatility whilst understanding the constraints that different end-effectors and materials place on the generation of robotic paths and code. Specific parameters will need to be considered for each of them and their machine and material behaviours will be incorporated to the design process.
3. Use of online tutorials and resources: for self-directed learning.
4. Use a range of tools and technologies for digital design and robotic fabrication, including different end effectors and material processes
5. Contextualize your work within the contemporary ecosystem of robotics in architecture

## **Learning Resources:**

PDF of the required readings will be provided by the instructor.

Reading list below:

Bhooshan, Shajay, and Alicia Nahmad Vazquez. 2020. “Homes, Communities and Games: Constructing Social Agency in Our Urban Futures.” *Architectural Design* 90 (3): 60–65.  
<https://doi.org/10.1002/ad.2569>.

Schumacher, Patrik. 2018. "The Progress of Geometry as Design Resource." Log, no. 43: 1–15. <https://www.anycorp.com/>.

Bhooshan, Shajay. 2017. "Parametric Design Thinking: A Case-Study of Practice-Embedded Architectural Research." Design Studies 52: 115–43. <https://doi.org/10.1016/j.destud.2017.05.003>.

Gramazio, Fabio, and Matthias Kohler. n.d. "Digital Materiality in Architecture Tary Logics in Relation to One Another ."

Malafouris, Lambros. 2008. "At the Potter ' s Wheel : An Argument for Material Agency." In Material Agency: Towards a Non-Anthropocentric Approach, edited by Carl Knappett and Lambros Malafouris, 19–37. Springer. <https://doi.org/10.1007/978-0-387-74711-8>.

Negroponte, Nicholas. 1969. "Toward a Theory of Architecture Machines." Journal of Architectural Education 23 (2): 9–12.

Picon, Antoine. 2004. "Architecture and the Virtual: Towards a New Materiality." PRAXIS: Journal of Writing + Building 6: 114–21.

Feringa, Jelle. 2014. "Entrepeneurship in Architectural Robotics: The Simultaneity of Craft, Economics and Design." Architectural Design: Made by Robots, 2014.

Lloyd Wright, Frank. 1901. "The Art and Craft of the Machine." Brush and Pencil 8 (2): 77–81, 83-85,87-90. <http://www.jstor.org/stable/25505640>.

## **Technology requirements (D2L etc.):**

In order to successfully engage in their learning experiences at the University of Calgary, students are required to have reliable access to the following technology:

A computer with a supported operating system, as well as the latest security, and malware updates

A current and updated web browser

### **An external mousse**

Webcam (built-in or external)

Microphone and speaker (built-in or external), or headset with microphone

Current antivirus and/or firewall software enabled

Broadband internet connection

During the class we will use Autodesk Maya, Rhino, grasshopper and a series of plugin for Rhino.

Most current laptops will have a built-in webcam, speaker and microphone

## **Workshop Safety Training Requirement**

If a course requires the use of the SAPL workshop, students must complete all online University of Calgary safety courses, the online Trajectory safety training course, as well as in-person workshop training and a grade of pass on the final evaluation project, to be granted access to the SAPL workshop. This training is offered once a year, around the start of the Fall term and has a completion deadline.

## **Additional Classroom Conduct and Related Information**

### **Guidelines for Zoom Sessions in Online Classes**

Students are expected to participate actively in all Zoom sessions and to turn on their webcam. Please join our class in a quiet space that will allow you to be fully present and engaged in the Zoom sessions. Students must behave in a professional manner during the session. Students, employees, and academic staff are also expected to demonstrate behaviour in class that promotes and maintains a positive and productive learning environment

### **Assessment Components:**

Assessments carried out during the last 14 calendar days of classes in Fall/Winter Terms and the last 7 calendar days in Spring/Summer Intersessions (as defined in the [Academic Schedule](#)) may not total more than 15 per cent of the final grade, except in the case of laboratory or oral testing, presentations or summative projects/papers.

c. The final exam may not count for more than 50 per cent of the final grade, except in: (1) the cases of clinical or professional practice-based courses in academic programs leading to professional designation, registration and/or licensing (2) or in situations outlined in section [G.1.2 In-Course Assessments and Absences](#).

Assessment Method	Description	Weight	Aligned Course Learning Outcome
Catalogue 01	2D Robotics	20%	1 to 4
Design Explorations and Catalogue	3D Robotics	20%	1 to 4
Design explorations and catalogue submission	Working with Existing Geometry	20%	1 to 4
D2L responses	Response to weekly reading prompts	25%	5
Oral Presentations	Participation and Presentations	15%	1 to 5

## **Assessment and Evaluation Information**

### **Attendance and Participation Expectations:**

Students are expected to **attend all classes for the entire scheduled meeting time** and are responsible for completing assignments and for knowing the material covered in class. Students are allowed one absence without a final course grade reduction.

After the allowed absence a student's final course grade will be reduced one-half level for each additional absence (e.g. after the second absence from the course the final course grade will be lowered from a B+ to a B, after the third absence from a B to B-, etc.).

## **PARTICIPATION EXPECTATIONS**

Students are expected to attend all classes and participate in the discussions. They should come prepared to the class with readings, geometry and robot paths for discussion.

The TA in this course are expected to help and guide students through the assignments, help them understand and prepare code and robot paths and modeling questions. The Ta **IS NOT** expected to make robot paths for students, fix code or prepare raw material.

## **THE CLASS IS NOT A SHOP WHERE YOU DROP GEOMETRY AND EXPECTED FINISHED PIECES THE NEXT DAY.**

Programming robots requires an understanding of geometry constrains both on the robot motions and on the architectural pieces. **The only way to learn how to do this is by doing it**

**Final pieces without a clear design and fabrication process and without class participation won't be considered successful.**

### **Guidelines for Submitting Assignments:**

Submission should follow the format provided by the instructor. Deviations from the format would result in point deductions.

A final pdf catalogue documenting all the explorations produced during the course and a prototype is expected

### **Requirements for Assignments**

Assignments consist of a rigorous documentation of the work and steps taken throughout the course. It includes the graphic presentation of the material according to the course template. It should showcase digital and physical prototypes NOT as finished products but as the result of a comprehensive and iterative process.

The documentation should emphasise the parametric set up of modelling, design and fabrication parameters and their exploration in the design space. The document should be

clearly organised and structured and describe all aspects of the furniture & ornament process (design - data collection - ornamentation).

Each group will design a family of experimental studies and the combinatorial space in which they develop.

Digital and physical prototypes are to be catalogued, documented and submitted as a digital copy

### **Final Examinations:**

The course will have a final presentation of the design prototypes and the design and fabrication process and a final document submission. An interim document will be graded to give the students an indication of their progress.

The course is designed for collaborative / team work and both submissions (prototypes and catalogue) would be evaluated as such. **Individual submission or group project that lack coherence won't be admitted.**

**Active participation during the class is expected. Reliance on the TA to produce the code or the robot pieces is not acceptable.**

**Expectations for Writing** (<https://www.ucalgary.ca/pubs/calendar/current/e-2.html>):

### **Late Assignments:**

Late assignments will only be accepted on exceptional circumstances with the proper documentation to justify them and as discussed with the instructor.

### **Criteria that must be met to pass:**

All course documents must be submitted and attendance to all classes. Students are allowed one absence without a final course grade reduction.

After the allowed absence a student's final course grade will be reduced one-half level for each additional absence (e.g. after the second absence from the course the final course grade will be lowered from a B+ to a B, after the third absence from a B to B-, etc.).

### **Grading Scale:**

Grade	Grade Point Value	4-Point Range	Percent	Description
A+	4.00	4.00	95-100	Outstanding - evaluated by instructor
A	4.00	3.85-4.00	90-94.99	Excellent - superior performance showing comprehensive understanding of the subject matter

A-	3.70	3.50-3.84	85-89.99	Very good performance
B+	3.30	3.15-3.49	80-84.99	Good performance
B	3.00	2.85-3.14	75-79.99	Satisfactory performance
B-	2.70	2.50-2.84	70-74.99	Minimum pass for students in the Faculty of Graduate Studies
C+	2.30	2.15-2.49	65-69.99	All final grades below B- are indicative of failure at the graduate level and cannot be counted toward Faculty of Graduate Studies course requirements.
C	2.00	1.85-2.14	60-64.99	
C-	1.70	1.50-1.84	55-59.99	
D+	1.30	1.15-1.49	50-54.99	
D	1.00	0.50-1.14	45-49.99	
F	0.00	0-0.49	0-44.99	

A student who receives a "C+" or lower in any one course will be required to withdraw regardless of their grade point average (GPA) unless the program recommends otherwise. If the program permits the student to retake a failed course, the second grade will replace the initial grade in the calculation of the GPA, and both grades will appear on the transcript

The School of Architecture, Planning and Landscape will not permit the Flexible Grade Option (CG Grade) for any course offered by the School.

<https://www.ucalgary.ca/pubs/calendar/current/f-1-3.html>

### CACB Student Performance Criteria (for Architecture courses only)

The following CACB Student Performance Criteria will be covered in this course at a primary level (other criteria will be covered at a secondary level): A2: Design Skills; A5: Site Context and Desig.

## Topic Areas & Detailed Class Schedule

Course Schedule Date	Topic	Assignments/Due Dates
Jan 8 – 12	<p><b>"Designing for Digital Fabrication"</b> <b>LECTURE</b></p> <ul style="list-style-type: none"> <li>- Introduction, presentation of robots in architecture.</li> <li>-Software intro</li> <li>-Team assembly</li> <li>-Robotic Fabrication and documentation techniques</li> </ul>	Answer to weekly prompt

Jan 15 – 19	<p><b>“Designing for Digital Fabrication”</b></p> <p><b>LECTURE</b></p> <ul style="list-style-type: none"> <li>- Machinic Agencies / Robotic Fundamentals</li> <li>/IK/FK/Frames/Rotations/Transformations</li> </ul> <p><b>PROTOTYPING</b></p> <p><b>-2D robotics</b></p>	Answer to weekly prompt
Jan 22 – 26	<p><b>“Designing for Digital Fabrication”</b></p> <p><b>LECTURE</b></p> <ul style="list-style-type: none"> <li>-Robotic simulations and code generation</li> <li>-End Effectors design and fabrication</li> </ul> <p><b>PROTOTYPING</b></p> <p><b>- 2D robotics and drawing operation</b></p>	Answer to weekly prompt
Jan 29 – Feb 2	<p><b>“Machinic Agencies”</b></p> <p><b>LECTURE</b></p> <ul style="list-style-type: none"> <li>- Intro to form-free modelling and ruled surfaces (modelling for digital Fabrication)</li> </ul> <p><b>PROTOTYPING</b></p> <p><b>- 3D robotics (RHW)</b></p>	<b>2D robotics 20%</b>  Answer to weekly prompt
Feb 5 – 9	<p><b>“Machinic Agencies”</b></p> <p><b>LECTURE</b></p> <ul style="list-style-type: none"> <li>- Robots on 3D space – vector operations and code preparation</li> </ul> <p><b>PROTOTYPING</b></p> <p><b>- 3D robotics (RHW)</b></p>	Answer to weekly prompt
Feb 12 – 16	Winter SAPL Block week	
Feb 19	Family Day Observed	
Feb 19 – 23	Winter Term Break	
Feb 26 – Mar 1	No Lecture, team work and prototyping  <p><b>PROTOTYPING</b></p> <p><b>- 3D robotics (RHW)</b></p>	Answer to weekly prompt
Mar 4 – 8	<p><b>“Data Collection”</b></p> <p><b>LECTURE</b></p> <ul style="list-style-type: none"> <li>-Scanning technologies, data retrieval and manipulation</li> </ul>	<b>3D robotics (20%)</b>

	<p>-Data collection in the building industry</p> <p><b>PROTOTYPING</b></p> <p>- Generation of ornament on existing RHWC pieces</p>	Answer to weekly prompt
Mar 11 – 15	<p><b>“Data Collection”</b></p> <p><b>LECTURE</b></p> <p>- Point clouds &amp; Feedback loops</p> <p><b>PROTOTYPING</b></p> <p>- Robotic sequences on existing information</p>	Answer to weekly prompt
Mar 18 – 22	<p>“Data Collection”</p> <p><b>LECTURE</b></p> <p>- working with existing information, different tools and end effectors</p> <p><b>PROTOTYPING</b></p> <p>- Robotic sequences on existing information</p>	Answer to weekly prompt
Mar 25 – 28	<p><b>PROTOTYPING</b></p> <p>- Robotic sequences on existing information</p> <p>-Working with existing 3D information</p> <p>- Robotic prototyping</p>	Answer to weekly prompt
Mar 29	Good Friday – University closed	
Apr 1	Easter Monday – University closed	
Apr 2 – 5	<p><b>PROTOTYPING</b></p> <p>- Robotic sequences on existing information</p> <p>-Working with existing 3D information</p> <p>- Robotic prototyping</p>	
Apr 8 – 9	<b>Final Presentations and Discussion</b>	<b>Working with Existing Geometry 20%</b>
Apr 15 – 19	Final Review week	
Indicate the following dates:		
<ul style="list-style-type: none"> <li>• If applicable, dates, times and locations of all approved class activities scheduled outside of regular course hours</li> </ul>		

## Special Budgetary Requirements

Special budgetary requirements are limited to the optional purchase of course readings and, in specific courses, mandatory supplementary fees to cover certain expenditures, such as field trips. Mandatory supplementary fees must be approved by the University prior to implementation. Instructors are required to list and describe approved optional and mandatory supplementary fees for courses. This can include possible costs incurred for special materials, equipment, services, or travel.

**Optional:**

For certain courses students may be given the option of purchasing course readings. In these cases the cost of the reading package should be stated in the course outline. When course readings are available for purchase, a minimum of two copies of the readings must be made available at the SAPL Reception or online.

## University of Calgary Policies and Supports

### **ACADEMIC ACCOMMODATION**

It is the student's responsibility to request academic accommodations according to the University policies and procedures listed below. The student accommodation policy can be found at: <https://www.ucalgary.ca/legal-services/university-policies-procedures/student-accommodation-policy>

Students needing an accommodation because of a disability or medical condition should communicate this need to Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities: <https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Accommodation-for-Students-with-Disabilities-Procedure.pdf>. Students needing an accommodation in relation to their coursework or to fulfil requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, preferably in writing, to their instructor (contact information on first page above).

SAS will process the request and issue letters of accommodation to instructors. For additional information on support services and accommodations for students with disabilities, visit [www.ucalgary.ca/access/](http://www.ucalgary.ca/access/).

### **ACADEMIC MISCONDUCT**

Academic Misconduct refers to student behavior which compromises proper assessment of a student's academic activities and includes: cheating; fabrication; falsification; plagiarism; unauthorized assistance; failure to comply with an instructor's expectations regarding conduct required of students completing academic assessments in their courses; and failure to comply with exam regulations applied by the Registrar.

For information on the Student Academic Misconduct Policy and Procedure please visit: <https://www.ucalgary.ca/legal-services/university-policies-procedures/student-academic-misconduct-policy>

Additional information is available on the Academic Integrity Website at <https://ucalgary.ca/student-services/student-success/learning/academic-integrity>.

### **COPYRIGHT LEGISLATION:**

All students are required to read the University of Calgary policy on Acceptable Use of Material Protected by Copyright (<https://www.ucalgary.ca/legal-services/university-policies-procedures/acceptable-use-material-protected-copyright-policy>) and requirements of the copyright act (<https://laws-lois.justice.gc.ca/eng/acts/C-42/index.html>) to ensure they are aware of the consequences of unauthorised sharing of course materials (including instructor notes, electronic versions of textbooks etc.). Students who use material protected by copyright in violation of this policy may be disciplined under the Non-Academic Misconduct Policy (<https://www.ucalgary.ca/pubs/calendar/current/k.html>).

### **INSTRUCTOR INTELLECTUAL PROPERTY**

Course materials created by instructors (including presentations and posted notes, labs, case studies, assignments and exams) remain the intellectual property of the instructor. These materials may NOT be reproduced, redistributed or copied without the explicit consent of the instructor. The posting of course materials to third party websites such as note-sharing sites without permission is prohibited. Sharing of extracts of these course materials with other students enrolled in the course at the same time may be allowed under fair dealing.

### **FREEDOM OF INFORMATION AND PROTECTION OF PRIVACY**

Student information will be collected in accordance with typical (or usual) classroom practice. Students' assignments will be accessible only by the authorized course faculty. Private information related to the individual student is treated with the utmost regard by the faculty at the University of Calgary.

### **SEXUAL AND GENDER-BASED VIOLENCE POLICY**

The University recognizes that all members of the University Community should be able to learn, work, teach and live in an environment where they are free from harassment, discrimination, and violence. The University of Calgary's sexual violence policy guides us in how we respond to incidents of sexual violence, including supports available to those who have experienced or witnessed sexual violence, or those who are alleged to have committed sexual violence. It provides clear response procedures and timelines, defines complex concepts, and addresses incidents that occur off-campus in certain circumstances. Please see the policy available at <https://www.ucalgary.ca/legal-services/university-policies-procedures/sexual-and-gender-based-violence-policy> .

### **UNIVERSITY STUDENT APPEALS OFFICE**

If a student has a concern about a grade that they have received, they should refer to Section I of the Undergraduate Calendar (<https://www.ucalgary.ca/pubs/calendar/current/i-3.html>) which describes how to have a grade reappraised. In addition, the student should refer to the SAPL's Procedure for reappraisal of grades

## **OTHER IMPORTANT INFORMATION**

Please visit the Registrar's website at: <https://www.ucalgary.ca/registrar/registration/course-outlines> for additional important information on the following:

- Wellness and Mental Health Resources
- Student Success
- Student Ombuds Office
- Student Union (SU) Information
- Graduate Students' Association (GSA) Information
- Emergency Evacuation/Assembly Points
- Safewalk